Missouri Department of Natural Resources
"Integrity and excellence in all we do"

Collection, Handling and Reporting Procedures for Groundwater Samples

Solid Waste Management Program fact sheet 7/2003

Introduction

A significant portion of the solid waste generated in Missouri is disposed of in landfills permitted and regulated by the Missouri Department of Natural Resources' Solid Waste Management Program (SWMP). All landfills are required to install monitoring wells to collect groundwater samples for analysis to determine whether or not the landfill is having an impact on the groundwater. In addition, most landfills are required to collect and analyze surface water samples.

The Department of Natural Resources' Environmental Services Program (ESP) may collect or split samples with landfills during the SWMP's Quality Assurance sampling. ESP does not contract with landfills to conduct private sampling.

Representative and comparable analytical data and detailed records for groundwater or surface water monitoring programs are dependent on consistent and reliable sampling methods, detailed field observations and analytical techniques. The following guidelines describe collection, handling and reporting procedures.

Sampling Methodology

Landfills are required to establish groundwater monitoring programs and should follow these methods of sampling each time samples are collected.

A. Field Logbooks

Field logbooks should be maintained for each sampling point in the groundwater monitoring program. Field logbooks should include field observations, developing, purging and well or surface monitoring point sampling details.
Additionally, all field logbooks should contain the following information:

1. Landfill name
2. Landfill permit number
3. Four digit groundwater monitoring point number
4. Laboratory name, address and phone number
5. Sample collector's name and affiliation (i.e., landfill, lab or contract personnel)
6. Weather conditions (such as rain) that could affect the sample
7. General condition of well and wellhead
8. Maintenance performed involving no potential sample contamination
9. Depth to water prior to purging
10. Determination of accumulated sediment thickness in the bottom of the well
11. Wetted well casing volume

PUB000181

12. Well recharge rate identified or described
13. Starting and ending times for well purging
14. Pumping rate
15. Water level measurement at time sample collected (Include an explanation if the well water level is not fully recovered.)
16. Decontamination procedures
17. Equipment calibration
18. Field measurements
19. Field Quality Assurance/Quality Control (QA/QC) samples
20. Any indication of redevelopment required
21. Sample collection date and time
22. Date and time sample was shipped to laboratory
23. Name of laboratory
24. Complete explanation for any deviation from these guidelines.

B. Surface Water Monitoring

Landfills are required to monitor surface water. All landfills are required to have storm water permits from the Water Pollution Control Program (WPCP). Contact WPCP at (573) 751-1300 for requirements concerning surface water sampling. Additionally, some landfills have site-specific monitoring requirements as part of their solid waste disposal area construction permit.

C. Monitoring Wells

To ensure samples are identified and collected at the correct location, monitoring wells should be marked with the four digit monitoring point numbers designated in the approved groundwater monitoring program. The numbers should be painted on pipe casings, or on adjacent permanently installed signs identifying each well. Well casings may be painted with fluorescent paint to make them more visible. Apply paint with a brush and not with an aerosol paint can to avoid contaminating the well.

Wells must have permanently marked reference points from which groundwater levels and well depths are always measured. Elevations of reference points must be established relative to permanent benchmarks. Benchmarks should be established relative to the *North American Vertical Datum of 1929 or 1983*, whichever is available. All sampling points should use the same datum.

Upgradient wells should be sampled first to avoid cross contamination. In general, this procedure is intended to sample the least potentially contaminated monitoring point first, and subsequently sample all other monitoring points with increasing contamination potentials.

Three principal steps in collecting groundwater samples from monitoring wells are measuring static groundwater levels; evacuating or purging well bores and casings; and collecting and preserving samples. Each step must be performed consistently from well to well, and from one sampling event to the next if accurate data and representative samples are to be obtained.

C.1. Static Groundwater Level, Total Well Depth and Total Well Volume

Static elevations of groundwater should be measured prior to purging. Initially, depths to static groundwater levels should be measured from each well's specified reference point during each sampling event in order to calculate each well's initial groundwater volume. Groundwater eleva-

tions in wells are obtained by subtracting measured depths to groundwater from each well's specified reference point elevation.

Each monitoring well depth should be measured as the distance from the reference point to the well bottom. Record these depths at each sampling event prior to purging. A decrease in well depth, from the well's known installed total depth, may indicate that sediments have been deposited in the well. If accumulated sediment obstructs approximately 10 percent of the well's screened interval length, then the well should be redeveloped.

The two most common devices used to measure well depth and groundwater level are weighted tape measures and electronic droplines. Tape measures should be weighted with an inert material such as stainless steel and then lowered into wells until they make contact with the groundwater.

Electronic droplines are battery-powered devices with probes that are lowered into wells until an audible signal, a light or a meter indicates contact has been made.

All parts of measuring devices coming in contact with groundwater must be thoroughly washed with a non-phosphate detergent and triple rinsed with deionized or distilled water immediately after each use to avoid contamination between wells.

The difference between installed total well depth and depth to static groundwater level is the stabilized height of the groundwater column in the well. Accumulated sediment is not subtracted when calculating the volume of groundwater in the well, resulting in a greater and more conservative estimate of purge volume. These measurements are used to determine the static well volume (in gallons) of groundwater in each well as follows:

1. In order to obtain the height (H) of the groundwater column, measure the well's known installed total depth (TD) and subtract its measured depth to static water level (MSD)

$$H = TD - MSD$$

2. Use the following formula to calculate the static well volume (in gallons) of groundwater:

$$V = 5.875 \times D^2 \times H.$$

Where:
V = Well volume (gallons)
D = Inside well diameter (feet)
H = Height of groundwater column (feet)

C.2. Monitoring Well Purging

Before purging and sampling, a clean container, trash bag or plastic sheeting should be placed around or next to monitoring wells to aid in preventing contamination of equipment.

Purging wells prior to sample collection is necessary to remove stagnant groundwater which may not be representative. It is strongly recommended that dedicated purging equipment be used to purge each monitoring well. Purging should be done at a rate as close as possible to the well's recharge or recovery rate.

It is recommended to purge three to five well casing volumes if possible, but this purge volume

should be treated as a starting point. Accurate estimation of purge volume requires knowing well yield from a slug or pumping test, and the stagnant volumes of both the well casing and the sand pack. For a well that can be pumped or bailed dry with the sampling equipment being used, the well should be evacuated and allowed to recover prior to sampling. When recovery is rapid, evacuation of more than one volume of water is recommended.
When sampling groundwater monitoring wells, the purge water must be disposed in accordance with permitting requirements under the *Missouri Clean Water Law* (MCWL) and regulations. Purge water will need to be collected and transported to a permitted treatment facility or handled in accordance with the MCWL permit for the operation. Contact the department's Water Pollution Control Program for specific requirements.

A well with a high recharge or recovery rate is evaluated qualitatively in the field as any well that can maintain a stable pumping level above the pump intake during purging. Purging with a pump for high yielding wells is recommended.

Wells should be purged from the slowest to fastest recharging wells to allow adequate recovery time prior to additional purging or sampling.

If dedicated purging equipment is not used then equipment must be properly cleaned (see Equipment Cleaning, page 8). The department recommends that retrieval ropes be used only once and then discarded.

Bailer Purging

When a bailer is used to purge a well, it must be made of material that will not alter sample parameters. When sampling for organics, Teflon is the recommended material of choice and stainless steel is the second choice. Polyvinylchloride (PVC) bailers are not recommended for sampling organic constituents.

Once appropriate bailers and rope have been selected, wells should be purged as follows:
1. Slowly lower the bailer down the well until the bailer top is below the groundwater surface.
2. Retrieve the bailer slowly, record the actual volume of groundwater removed and properly dispose of its contents.
3. Continue bailing recharging wells slowly until at least one static well volume has been removed or until they are dry.

Pump Purging

When pumping devices are used to purge wells, pump discharge rates must be regulated or controlled to prevent turbulent flow; prevent damage to monitoring well components; and to minimize introduction of sediments into the monitoring well.

Once appropriate pump(s) have been selected, wells should be purged as follows:

1. After one well volume has been removed, record pH, specific conductivity, and turbidity or redox potential and the temperature of the sample in degrees Celsius.

2. Continue pumping until a second well volume has been removed and record the same purging parameters again. If the difference in pH value between the first and second well volume purged is 0.2 units or less, and if the difference between the temperature, specific conductivity and redox potential values between these two well volumes is 10 percent or less, then the well

has been sufficiently purged and may be sampled.

3. If any of the purging parameters have not stabilized between the first and second purged well volume, then a third well volume must be purged. Purging parameters should again be recorded and compared to the second well volume purging parameters. Continue this process until all purging parameters stabilize.

4. After sufficient well volumes have been removed and purging parameters are stabilized, non-dedicated pumps must be removed. Finally, one additional well volume should be removed by bailing.

Micropurging

For low recovery rate monitoring wells, micropurging may be implemented to obtain representative samples from the groundwater bearing zone being monitored. A dedicated pumping device installed permanently in the well or a portable pumping device installed at least 24 hours prior to purging and sampling is required to allow the water column to equilibrate. The pump intake must be near the middle of the well screen. Pumping flow rates must be less than natural recovery rate of the well and continuous monitoring of water level and water quality indicator parameters for stabilization.

C.3 Sample Collection

Groundwater monitoring wells should be sampled as soon as they have recharged, and within 24 hours after they have been purged. Remember to measure or record the depth to static groundwater level immediately prior to sampling. All groundwater monitoring well samples from the same saturated zone should be collected during the same sampling event. All wells should be sampled within five days of the start of a sampling event.

Groundwater samples should be collected using a device that is appropriate for the type of well installation and for the parameters of concern. Section 5, pages 5-1 through 5-6 of *EPA/6251R-93/003a*, May 1993, provide further guidance on selection of sampling devices. It is strongly recommended that sampling devices be dedicated for each well, or be thoroughly washed between wells.

Bailer samples are collected by slowly and gently lowering the bailer down the well until the top of the bailer is below the groundwater surface. Care should be taken to avoid sample disturbance and to minimize aeration of samples or groundwater in the well. Do not allow any bailer to fall freely into the well; minimize contact with the well sides and avoid contact with the bottom since this may allow any attached or settled out sediments to be incorporated into the samples. Retrieve the bailer slowly. Carefully empty groundwater samples directly into the appropriate containers. All air space in sample containers or vials must be eliminated when sampling for volatile organic compounds (VOC). Conduct volatile organic compound, and total organic carbon (TOC) sampling with a dedicated Teflon bailer or a thoroughly decontaminated stainless steel bailer. If the well condition prohibits this type of sampling, a positive displacement bladder pump operating at a rate of less than or equal to 0.1 liter per minute is recommended.

Sample Handling

Sample handling and preservation techniques depend on the parameters to be analyzed. Groundwater samples should be collected, preserved and containerized in their order of sensitivity to volatilization (most sensitive to least sensitive).

The purpose of sample preservation is to stabilize parameters of interest by retarding chemical or biological changes. Methods of preservation are generally limited to pH adjustment, chemical addition and cooling. Samples requiring preservation should be preserved immediately upon collection. Proper preservation will help ensure that samples are representative of groundwater.

Every sample must be cooled to 4 C (approximately 39 F) immediately after being containerized and preserved. Every sample must also be maintained at 4 C until analyzed.

Note: Please contact the Department of Natural Resources' Environmental Services Program at (573) 526-3315, or your laboratory, for information regarding appropriate containers, preservatives and holding times.

Groundwater samples that are to be analyzed for total recoverable metals must not be field filtered.

However, if dissolved metals analyses are required, then the samples must be field filtered through a 0.45-micron filter immediately upon collection and prior to preservation and transport to a laboratory.

Field measurements for the indicator parameters of pH, temperature and specific conductivity should be taken on a portion of the sample that has been placed in a separate clean container that will not be analyzed for any other parameters. This procedure avoids cross contamination from field instrument probes.

A final sample should be taken for immediate field measurement and recording of field parameters such as temperature, pH, specific conductivity and redox potential. This last field sample is used only to determine if purging parameters have changed during sampling.

Field instrument probes must be properly cleaned between measurements on different samples.

Sample Documentation and Chain-of-Custody

Samples to the laboratory generally include the following documentation:

Chain-of-Custody records - These records document in a legally defensible manner the history of collection, transfer and transport of each sample. Every individual, who is responsible for the samples from the time of collection to the time they are received by a laboratory, must be documented in the Chain-of-Custody record. Chain-of-custody document records allow tracing the possession and handling of individual samples from the time of field collection through the time of laboratory analyses.

- Sample labels - To prevent misidentification of samples; must be in indelible ink:
- Sample seals - To preserve integrity of samples from time collected until opened in laboratories.
- Field logbook - To record information about each sample collected from each monitoring point in groundwater and surface water monitoring programs; and
- Sample analysis request sheets - To serve as official communication to laboratories for parameters to be analyzed for each sample.

The Department uses form # *MO 780-0320* (11-88) as a *Field Sheet and Chain-of-Custody record*.

Collection of Equipment Blanks

When non-dedicated bailers or pumps are used, the effectiveness of cleaning and decontamination procedures should be verified by collecting and analyzing equipment blanks. After cleaning, equipment blanks are prepared by filling the sampling device with deionized or distilled water and then emptying this water into sample containers. Equipment blanks should be handled and analyzed in the same manner as other samples being collected.

Equipment blanks should be collected between downgradient wells at a minimum of one per day, or one every five downgradient wells, if more than five wells are sampled in the same day at the same site. Additionally, each time a well of known or suspected contamination is sampled, an equipment blank should be collected.

Collection of Trip Blanks

When analyzing groundwater samples for organics, the potential influences of sample collection and transportation on sample quality should be assessed by preparing and analyzing trip blanks. Prior to departing for the sampling event, sample collectors should pack trip blanks along with other equipment taken to the field.

Trip blanks are containers of deionized or distilled water carried in each sample collector's vehicle during the day's sampling trip. At the end of the sampling event, trip blanks are stored with other samples to be transported.

A minimum of one set of trip blanks for each day of each sampling event should be analyzed and the results used to evaluate the quality of sample transportation. Trip blanks should be analyzed for all organic parameters for which the actual samples are analyzed.

Equipment Cleaning

All purging and sampling equipment, including bailers and pumps, must be cleaned prior to use. A complete wash with a non-phosphate detergent and a thorough triple rinse, both inside and out with deionized or distilled water, is the minimum acceptable cleaning method.

If equipment blank analyses do not indicate cross contamination, then the minimum acceptable cleaning method is adequate.

The following decontamination procedures are recommended when the minimum acceptable cleaning method described has not proven adequate:

When collecting samples for inorganic analyses, the recommended procedures for decontamination are:

- Washing equipment with a non-phosphate detergent,
- Rinsing with a dilute solution (0.1 N) of hydrochloric acid or nitric acid, and a
- Final triple rinsing with deionized or distilled water.

When organics are being analyzed, the above steps should be followed by an acetone rinse and then followed by a final triple rinse using deionized or distilled water.

A summary of decontamination solutions and solvents is provided in *EPA 625/R-93/003a,* May 1993, (see References, page 8).

Decontamination procedures or solvents other than those described above should be discussed with ESP staff prior to use.

Quality Control

It is recommended that each landfill owner or operator develop a Quality Assurance/Quality Control (QA/QC) plan. This plan will allow the assessment of sample collection accuracy and laboratory precision by landfill owner or operators.
Quality control checks should be incorporated into the sampling and analysis program. Quality control checks should be accomplished by ensuring that proper field calibration, sampling, transporting, analytical and documentation procedures are followed.

All equipment and instruments used in the field must be calibrated according to manufacturer's specifications. The costs associated with investigating false positives far outweigh the expense of maintaining an effective QA/QC program. For more information, see Table B.1, Appendix page B-3 of EPA ORD publication *EPA/625/R-93/003a*, May 1993, *Subsurface Characterization and Monitoring. Techniques, A Desk Reference Guide, Volume 1: Solids and Ground Water Appendices A and B.*

Reporting

Each laboratory should have standard operating procedures and maintain full documentation of all analytical work. A quality control chart should be maintained to document precision, accuracy and completeness.

Prior to detection monitoring, a minimum of four quarters of indicator and Appendix I parameter results are required as part of baseline groundwater monitoring statistical evaluation. Quarterly samples must be taken by the ends of February, May, August and November. Extended baseline monitoring may be required based on statistical methods or SWMP requirements. SWMP may allow, on a case by case basis, a certain amount of data taken into the detection monitoring to be incorporated as baseline data.

Baseline monitoring is required for any new well added to the program. A detection monitoring program follows acceptable baseline monitoring.

Following are the required time frames for semi-annual sample collection in approved groundwater monitoring programs. Corresponding time frames for submittal of data are also listed.

Semi-Annual Sampling

Samples must be taken by the end of May and November for semi-annual sampling events. Indicator and Appendix I parameter results, and results of statistical analysis determining statistically significant increases or statistically significant decreases for any parameters, must be submitted to SWMP within 90 days of sampling.

The electronic submission of groundwater data is required, in a format and method, prescribed by the department.

References

EPA. 1985 *Practical Guide for Groundwater Sampling.* EPA-60012-85-104, EPA, Ada, Oklahoma, 1985.

EPA. 1986 *RCRA Ground-Water Monitoring Technical Enforcement Document.* OSWER9950.1, September, 1986

EPA. 1993 Subsurface Characterization and Monitoring Techniques, A Desk Reference Guide Volume 1: Solids and Ground Water Appendices A and B. EPA/625/R-93/003a, May, 1993

EPA, 1991 *Handbook of Suggested Practices for the Design and Installation of Ground-Water Wells.* EPA-600-4-88-034, March, 1991.

Practical Handbook of Ground-Water Monitoring edited by David M. Nielsen, 1991.
Groundwater and Wells - Second Edition by Fletcher G. Driscoll, 1986.

Other References

Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Air Pollution Control Program	(573) 751-4817
Environmental Services Program	(573) 526-3315
Hazardous Waste Program	(573) 751-3176
Solid Waste Management Program	(573) 751-5401
Water Pollution Control Program:	(573) 751-1300
Public Information Program	(573) 751-3443 or 1 -800-334-6946
Geological Survey and Resource Assessment Division	(573) 368-2100

EPA Region 7
901 N. 5th Street
Kansas City, MO 66101

Solid Waste Program	(913) 551-7523
Hydrogeology Section	(913) 551-7690
Publications Hotline	1-800-424-9346

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(EPA Publications) 1-800-553-6847

National Ground Water Association
6375 Riverside Drive
Dublin, Ohio 43017
NGWA (614) 898-7791

EPA, ORD publication EPA/625/R-93/003a, May 1993, Subsurface Characterization and Monitoring Techniques, A *Desk Reference Guide, Volume 1: Solids and Ground Water Appendices A and B.*

Micropurge Low-Flow Purging and Ground-Water Sampling
The Nielsen Environmental Field School
4686 State Route 605 South
Galena, Ohio 43021-9652

For more information

Missouri Department of Natural Resources
Solid Waste Management Program
P.O. Box 176
Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 751-5401 office
(573) 526-3902 fax
www.dnr.mo.gov/alpd/swmp